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SOME FINANCIAL CONSIDERATIONS TO ASSESS THE FEASIBILITY OF INTENSIVE THERMAL FRESHWATER PRAWN AQUACULTURE

Report No. 90-286-K

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and
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ABSTRACT

The culture of the freshwater prawn, Macrobrachium rosenbergii, in temperate climates may be financially feasible by using intensive culturing techniques, economic construction methods and waste heat from industrial sources. Intensive freshwater prawn culturing techniques developed at Ontario Hydro are reviewed. Strategies for minimizing capital and operating costs and improving product value are examined. Net revenues available for carrying capital costs and profit are estimated using various production level and market price scenarios.

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EXECUTIVE SUMMARY

SOME FINANCIAL CONSIDERATIONS TO ASSESS THE FEASIBILITY OF INTENSIVE THERMAL FRESHWATER PRAWN AQUACULTURE

P. Niklas, Lead Technician
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Intensive thermal aquaculture of freshwater prawns has been shown to be technically feasible on a research scale at Ontario Hydro. Studies have reached a stage where further research must deal with the unknowns of commercial scale thermal prawn culture. A pilot scale project would be the most cost effective method of addressing these issues. The purpose of this preliminary economic evaluation is to provide focus and scope for the construction and operation of such a facility. A review of our research results in economic terms can be used to define both anticipated gross income as well as anticipated costs and how these costs are most likely to be distributed.

The most significant contributors to capital costs and operating costs were defined. Raceways (ponds) and structures to house them contribute 75-85 % of expected capital costs. Heat and food contribute 70-85 % of expected operating costs. These were judged to be most amenable to cost reduction.

A number of production, market price and operating cost scenarios for a hypothetical 10 ha prawn farm were examined. Production levels ranged from 6 tonne/ha/yr to 12 tonne/ha/yr (8 tonne/ha/yr has been achieved at the Research Division). Market prices ranged from present wholesale prices ($10/kg) for small prawns to retail levels ($35/kg) for premium sized prawns. Operating costs were estimated to be $687,000 with and $1,121,000 without cost cutting measures. Assuming operating costs are minimized, income before servicing capital costs would be between $700,000 and $1,000,000 per annum for a 10 ha operation.

The interdependence of design, materials and construction methods and costs makes definition of capital costs difficult. Preparation for the pilot phase will begin to show if the potential income is sufficient to cover capital costs and provide a reasonable return on investment. However, ultimately the true capital and operating costs, as well as achievable production (and hence gross income), can only be determined by the experiences gained during the pilot phase followed by detailed financial analysis.

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To Dr. D. Mills
Director of Research

SOME FINANCIAL CONSIDERATIONS TO ASSESS THE FEASIBILITY OF INTENSIVE THERMAL FRESHWATER PRAWN AQUACULTURE

1.0 INTRODUCTION

In 1984 Ontario Hydro identified the freshwater prawn, Macrobrachium rosenbergii, as a candidate for commercial thermal aquaculture using "waste" heat from its generating stations. The choice of freshwater prawns over other species was based on two premises. One was its promise for intensive culture. Macrobrachium rosenbergii is a freshwater species which requires brackish water only during the larval stages of its life cycle. It has a high yield potential (15 -20 t/ha/yr (Sandifer and Smith, 1978)), grows rapidly to a large size and had a relatively high market value with a ready market demand (Ontario Hydro Research Division Report No 84-56-K). The other was that the technical aspects of extensive Macrobrachium aquaculture appeared to have been proven; freshwater prawns were already being cultured commercially in warmer climates.

Our research has confirmed that thermal freshwater prawn culture is potentially feasible on a commercial scale using "waste" heat. The technical aspects of various components of prawn culture have been examined and optimized on a research scale. Before moving to commercial production, a pilot scale facility would be a useful intermediate step to examine and perfect technical culturing and engineering aspects of full scale production. A review of the known economic factors involved in thermal freshwater prawn culturing scheme is necessary before the construction of a pilot scale facility. Such a preliminary economic survey will enable estimates of potential income to be made. By defining known costs, income available for carrying capital costs and a return on investment can be estimated. Such a survey will also provide focus for engineering solutions for cost cutting during the pilot phase.

2.0 EXTENSIVE PRAWN CULTURE

2.1 PRESENT PRACTICE

Presently Macrobrachium are cultured extensively in ponds in warm climates. Seed stock comes from berried females collected from growout ponds. The eggs are hatched and the larvae raised in brackish water to postlarvae (PLs). The Pls, which no longer require brackish water, are then stocked in freshwater growout ponds which are about 1-2 metres deep. Some growers allow the Pls to develop into juveniles before stocking in growout ponds.

Harvesting begins after about 8 to 10 months. There are two harvesting methods. In a single harvest system ponds are drained and all prawns harvested regardless of size before restocking. There are numerous undersized prawns because the animals' social interactions cause heterogenous individual growth (HIG). The result is a positively skewed size distribution with many small animals. A continuous harvest system attempts to manage HIG effects by harvesting only marketable animals at 2 to 4 week intervals and restocking on a continuing basis.

2.2 YIELD

Currently the estimated world average yield is about 1 t/ha/yr (Lin C.K. 1988). However, production rates of 1.2 to 3 t/ha/yr are being reported from the Caribbean (Alston, 1989). These higher yields are achieved by using a two phase growout scheme. The largest juveniles are regularly harvested from first phase ponds for growout in less densely stocked second phase ponds. Efficient harvesting also contributes substantially to higher production. Higher yields are achievable but are difficult to repeat consistently.

Yield depends on two groups of factors. One group consists of manageable parameters. These include biological factors such as growth rate and critical pond biomass and stock management factors such as stocking and harvesting strategies. The other consists of random factors such as weather, water quality and natural food availability which, in combination, cause variable production. This latter variable in extensive prawn culture results in financial risk. The high risk which is inherent in yield/profit variability can be partially reduced by large scale farming and by stock management (Samples and Leung, 1985).

3.0 INTENSIVE THERMAL PRAWN CULTURE

Extensive prawn aquaculture is not economically feasible at temperate latitudes. However, intensive thermal prawn culture, which involves the use of a closely monitored controlled environment, may be profitable because of these advantages:

1) 12 month growing season at optimal temperature (27-30 °C),
2) higher growth and production,
3) consistency of product and freshness at market,

4) premium prices,
5) proximity to markets,
6) reduced transportation and spoilage costs,
7) lower risk.

However, these advantages must be paid for in terms of increased capital and operating expenses. These expenses are increased by the requirement of heating, and some type of housing to minimize heat loss, through the colder seasons. Greenhouses are ideal for this purpose because of their relatively low cost per unit area. Our experience has also shown that natural light appears to improve the growth and appearance of the prawns. Since ponds are difficult to harvest and house efficiently, raceways about 1.5 metres deep must be constructed.

To offset these increased capital and operating costs, our research was aimed at maximizing production of marketable prawns by improving habitat, minimizing HIG and improving stock management. Our experiments showed yield can be increased: by improving habitat with substrate, by removing animals with poor growth potential and by size-sorting at specific time intervals and by stocking similarly sized prawns at densities appropriate to their size (Ontario Hydro Research Division Reports Nos. 86-267-K, 87-31-K, 87-136-K, 88-169-K and reports in preparation).

The management of stocks is similar to extensive prawn culture. Seed stock is produced by collecting berried females from growout raceways. Their eggs are hatched and the larvae raised in recirculated artificial brackish water to postlarvae. The PLs are then stocked in nursery raceways. After eight weeks juveniles are sorted and distributed in first phase growout raceways. Prawns are resorted and redistributed in second and third growout phase raceways at 16 and 24 weeks respectively. The first market-sized prawns can be harvested at the end of the second phase growout. All prawns are harvested at 32 weeks. Using this management scheme a production of about 8 t/ha/yr was demonstrated on a research scale. A production of 10-12 t/ha/yr may be achievable when these techniques are applied to a full scale facility. In addition, manageable risk can be significantly reduced since adjustments which maximize growth, yield and raceway usage are made at each sorting. The unmanageable risks of variable weather, water quality and natural food availability associated with extensive prawn culture do not apply.

4.0 REQUIREMENTS FOR FINANCIAL FEASIBILITY

The financial feasibility of thermal prawn culture depends on economies of scale to reduce capital and operating costs and make efficient use of labour. Since a minimum of three persons is required for harvesting and sorting, effective use of available labour dictates a minimum facility size of about 10 hectares. Based on current wholesale prices (~$16/kg (Alston, 1989)) and an 8 t/ha/yr production a 10 hectare operation would gross about $1.3 million/annum. This sum must cover capital and operating costs and provide a suitable return on investment. Note that land costs are undefined in this analysis and must be considered when calculating potential profit.

4.1 REDUCING CAPITAL COSTS

Table 1 summarizes the components of an intensive thermal prawn culture facility and estimates of their relative contribution to the total capital costs.

It is apparent that the structures required to house the raceways and the raceways themselves are the major contributors to capital expenses in the construction of an intensive thermal prawn aquaculture scheme. The capital cost of these components can be substantial, up to \$38 / m^2 of for greenhouses and up to \$100 /m^2 for concrete raceways. Thus potential entrepreneurs must focus on innovative techniques and/or materials for housing and raceway construction to ensure financial feasibility.

4.1.1 Greenhouses and Raceways

Housing and raceways cannot be considered separately as their function and design are mutually dependent. Construction methods which reduce raceway costs tend to increase greenhouse size/cost and vice-versa. Therefore a balance must be achieved between the cost of raceway construction and the cost to house the raceways. No doubt cost saving methods of greenhouse and raceway design and construction other than the examples that follow can be used. The important note is that these are the areas that are most amenable to cost reduction.

As the cost of building concrete raceways precludes their use, earth raceways lined with lagoon lining material can be used (Figure 1). However, this approach results in a considerable amount of area being lost to the earth berms required between raceways. This distance is dependent on soil type and would probably be a minimum of two meters using reinforced, straight-cut sides (Figure 2). This would increase the amount of unproductive area to be housed. The cost of housing the raceways may be reduced by covering most of each raceway individually and joining these at a central structure used for servicing groups of raceways (Figure 4). Some capital savings may be realized using this approach.

Ideally, to minimize heat loss, a greenhouse should house a number of raceways (Figure 5). An alternative to housing raceways individually is to maximize the area in the greenhouses used for culturing, that is, to reduce the area lost between raceways. This may be possible by innovative raceway design. By stepping the sides of the raceways a one metre strip of earth may suffice between raceways (Figure 3). This would result in a significantly larger area being available for culture. Although the effect on production has not been examined, it is known that shallow water is preferred by moulting animals. The availability of the stepped area may reduce stress and cannibalism during moulting. The result may be a further increase in yield through higher survival.

TABLE 1.

Estimated Relative Contribution of Capital Costs for an Intensive Prawn Culture Facility

Greenhouses	40 - 45 %
Raceways (Ponds)	35 - 40 %
Heat exchange and plumbing	10 - 20 %
Aeration	1 - 2 %
Substrate	1 - 2 %
Equipment (Harvesting, sorting, monitoring, etc)	3 - 5 %

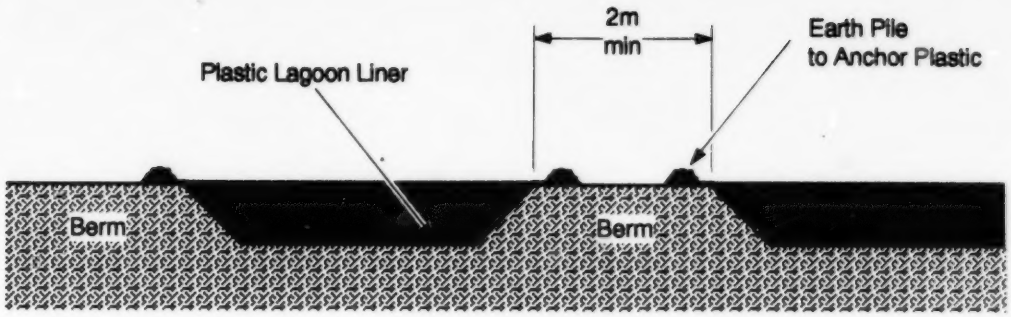

FIGURE 1

EARTH RACEWAYS LINED WITH PLASTIC MATERIAL

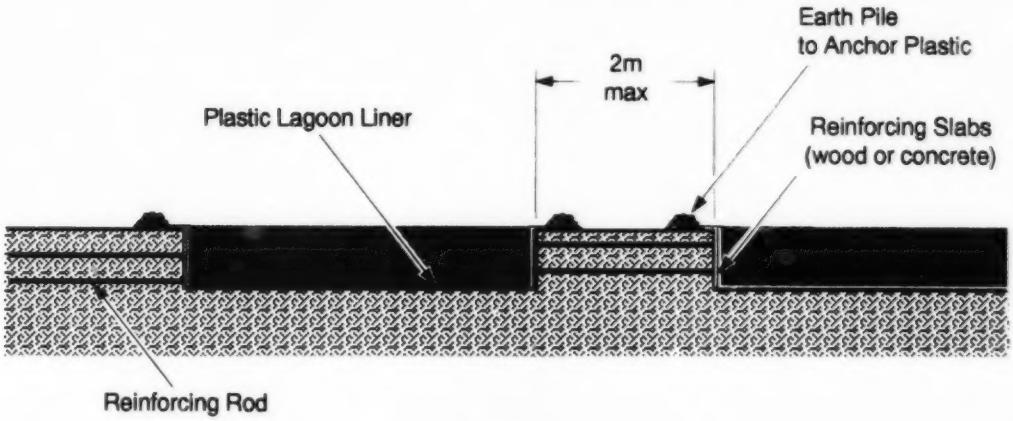

FIGURE 2

LINED EARTH RACEWAYS WITH REINFORCED SIDES

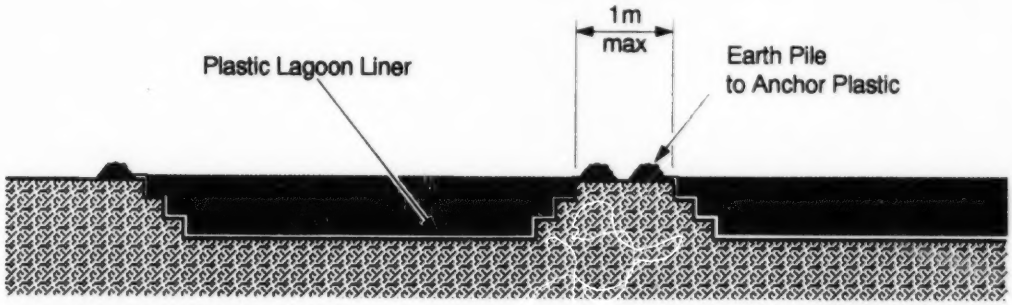

FIGURE 3

R ACEWAYS WITH STEPPED SIDES TO INCREASE PRODUCTIVE AREA

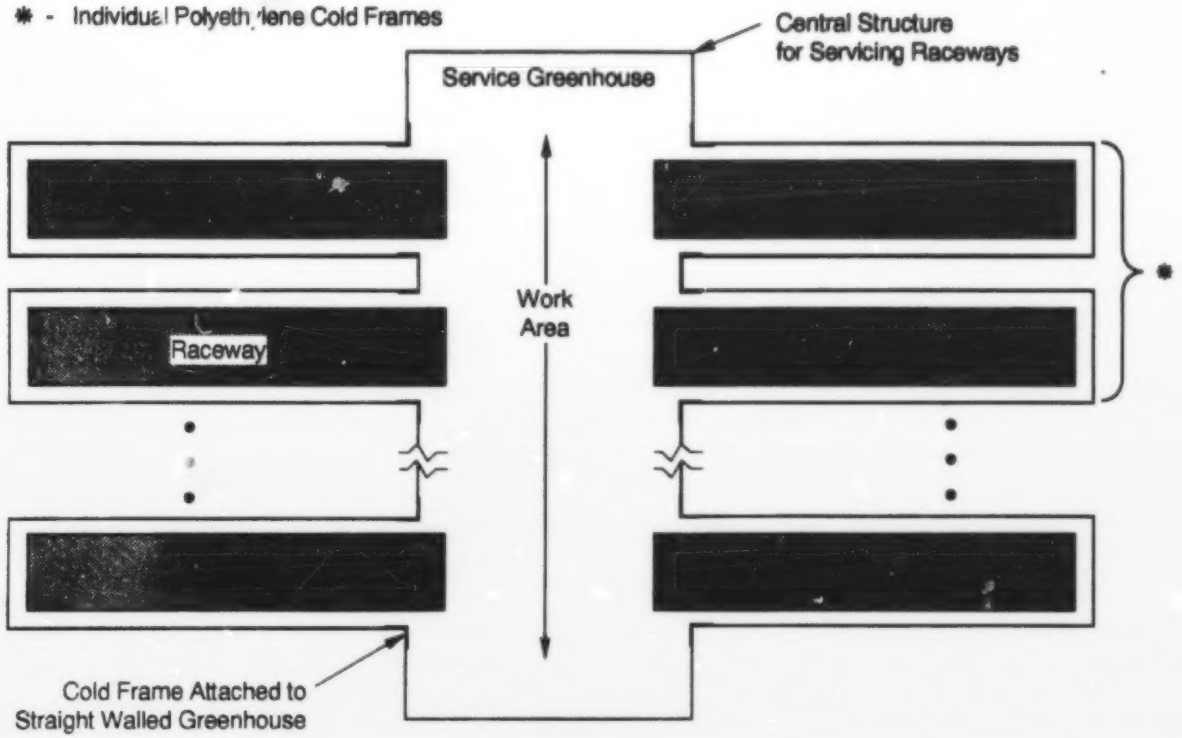

FIGURE 4

CENTRAL GREENHOUSE
WITH COLD FRAMES COVERING RACEWAYS

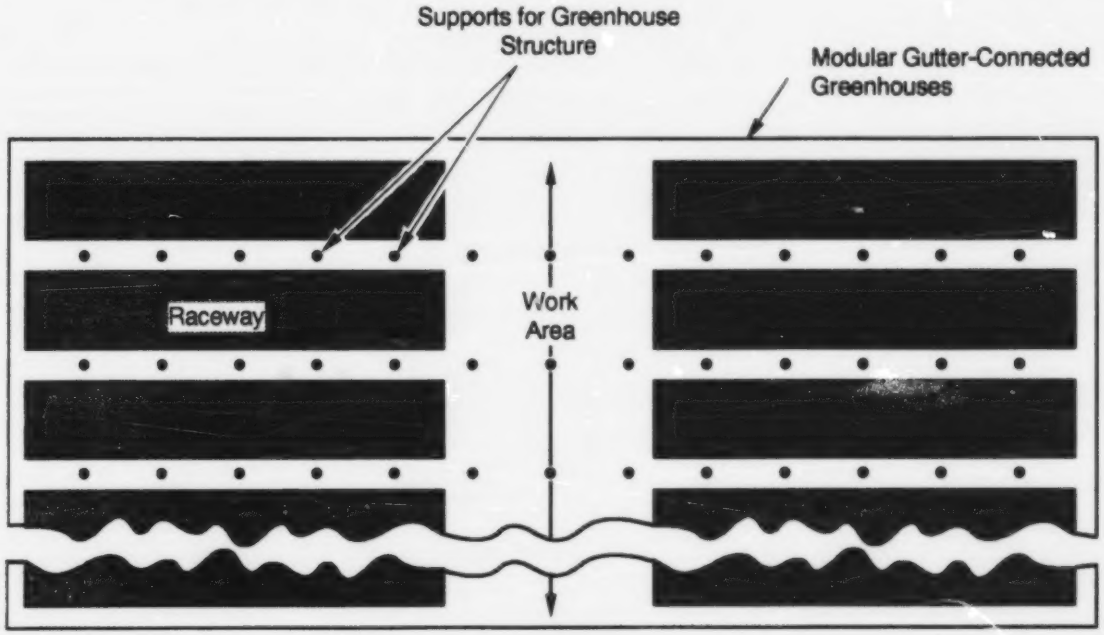

FIGURE 5

GREENHOUSE DESIGN TO MINIMIZE HEAT LOSS

4.1.2 Heat Exchange and Plumbing

Capital costs of heat exchange and plumbing are poorly defined but definitely follow housing and raceways in their contribution to total capital costs. Although some of our research has investigated the responses of prawns to water exchange rates (Ontario Hydro Research Division Report No. 87-105-K), the relative merits of various heat exchange and plumbing designs must be determined through engineering and/or pilot scale studies. Once water quality standards critical to production have been met, economy of construction and maintenance would be the priority in this area.

4.2 REDUCING OPERATING COSTS

Table 2 lists the operating expenses and their relative contribution to operating a thermal prawn culture facility.

Heating, food and labour costs have potential for reduction.

4.2.1 Heating Costs

Since this technology can be applied at any location with a reliable heat source of 30-40 °C it is possible for the company producing the heat to use the resource this way. In such a case heating costs would be virtually nil. If a steam heat source such as the one at the Bruce Nuclear Power Development is used, a shading system which consists of a 50 % energy retention fabric can be installed for approximately $100,000 per ha of greenhouse to reduce heat loss. Heating one hectare of water is estimated to cost about $45,000 per annum at current steam rates at Bruce Energy Centre (see Table 6). Such an installation would result in a pay-back in about 5 years.

4.2.2 Feed

Research has determined the optimum feeding levels using commercial prawn food supplemented with frozen fish flesh (Ontario Hydro Research Division Report No. 87-91-K). However, feeding costs could be further reduced by using alternatives to commercial prawn food. Since the animals are omnivores wastes from various food industries or from vegetable farming could be used. Even feeding back the small prawns with low growth potential can be used as a possible inexpensive food supplement.

4.2.3 Labour

Thermal prawn culture is labour intensive requiring frequent harvesting and sorting. It is assumed that sorting and harvesting time are reduced by using mechanical means. Further research may help in identifying an optimal sorting period thereby reducing sorting periods from three to two. This would allow staff to manage a larger area.

TABLE 2

Estimated Relative Contributions of Operating Expenses in an Intensive Prawn Culture Facility

Heat	35 - 45 %
Feed	35 - 40 %
Labour	7 - 10 %
PLs	3 - 6 %
Other (electricity, water, maintenance, etc)	10 - 15 %

4.3 MARKETING - OPTIMIZING INCOME

Reducing start-up and operating costs offers one approach to making intensive thermal prawn aquaculture feasible, however, advertising and marketing a unique freshwater product may be of equal importance.

Continuous harvesting allows the producer to provide a consistent, regulated supply of fresh product to the marketplace. This allows a number of market niches to be taken advantage of to enhance profits. Fresh products usually command premium wholesale and retail prices. Advertising and bringing to market a unique freshwater product which does not compete directly with frozen shrimp should lead to an increased sales price. This approach would fill a particular market niche - the "never frozen" product. The continuous harvest system also allows the producer to cater to the restaurant industry. The premium sized prawns could be reserved for this market resulting in higher returns. Direct retailing, which is common in Hawaii, can also increase revenue (prices are currently as high as $35.30/kg for 5-6 count freshwater prawns).

It should be noted that the costs that may be incurred in advertising, marketing and delivering the product have not been addressed in this analysis.

4.4 SEASONAL VERSUS YEAR-ROUND PRODUCTION

Another approach is to operate a facility on a seasonal basis or at a reduced level of production through the winter. This would involve using a combination of open ponds and covered raceways. The main production of prawns would occur in the warmest months of the year in low cost open ponds. Stock for marketing during winter would be housed in covered raceways probably at a reduced temperature and feeding rate. Larval and juvenile prawns would be reared during this period. Another approach would involve sorting out fast growing animals and rearing these premium prawns indoors while rearing slower growing animals in the ponds.

There would be a reduction of production when operating a prawn culture operation on a seasonal basis but the most significant capital and operating costs would be reduced. Outdoor ponds have few design restrictions and cost less than raceways. Greenhouse structures would only be required for housing larval and juvenile prawns being reared for the next growout. These prawns require little space due to their size. Thus considerably fewer raceways are required than for year-round production. Mature prawns being held for market during winter would be held at lower temperatures. Therefore operating expenses would also be significantly reduced during this period.

A combination of year-round and seasonal production strategies may ultimately result in the best return on investment.

Details of such production schemes have not been addressed by our research but would be an ideal area to investigate during the pilot phase.

5.0 EVALUATION

An intensive thermal prawn culturing scheme which yields 8 times the estimated world average has been developed at Ontario Hydro on a research scale. The potential for production on a commercial scale may approach, and perhaps surpass, 12 t/ha/yr. By minimizing capital and operating costs, and by enhancing price through marketing a fresh product, prawn culture may be economically feasible in Canada. A pilot scale facility would provide valuable experience in preparing for commercial operations. By defining the known costs and how costs are most likely to be distributed in such an aquaculture scheme, information can be gained during the pilot scale stage to minimize capital and operating costs in areas most amenable to reduction. Thus, a preliminary cost analysis will provide focus for the construction phase of the pilot. A review of the known economic factors affecting the success of a thermal freshwater prawn culturing scheme follows.

Operating costs of a commercial scale operation can be estimated with a reasonable degree of confidence . Estimates of ranges for gross income can be obtained from potential yields and current wholesale and retail market prices. In this way a range of values can be calculated for funds available to cover costs of carrying capital expenditures and for net profit.

Table 3 summarizes estimates of gross income from a range of potential yields and a range of wholesale prices and retail market prices for a 10 hectare operation. Gross income ranges from $600,000 at a wholesale price of $10.00 /kg and an annual yield of 6 tonne/ha to $4,200,000 at a retail price of $35.00 /kg and an annual yield of 12 tonne/ha. These gross incomes encompass a range from very poor yields and wholesale prices to optimistic yields and retail prices for premium sized prawns.

A more accurate estimate of income can be calculated for each annual yield, if a market size grading and pricing scheme is applied to these yields. Table 4 shows the proportion of prawn sizes harvested from a typical research scale growout and a targeted proportion which may be achievable on a commercial production scale (OHRDR in preparation). The range of sizes is due to the HIG effect previously mentioned. The prices that prawns command are related to their size, the smaller the count per unit weight the higher the price. Thus, actual gross incomes would depend on a number of factors ranging from prawn size to marketing methods. As discussed earlier, since a number of sizes will be harvested, different market strategies should be applied to different grades of prawns . Table 5 shows a grading scheme and two production scenarios, achieved distribution of prawn sizes (demonstrated on a research scale) and targeted distribution of prawn sizes (estimated commercial scale), and two scenarios of market prices. The small prawns (high counts per pound) would be marketed in bulk on a fresh wholesale basis to grocery chains. The large size prawns would be marketed as a fresh premium product to restaurants at close to "retail" prices or could be marketed directly to the public at retail prices. It should be noted that this approach would incur marketing costs which have not been defined here. Gross farm incomes range from about $85,000 with a 6 tonne/ha/yr production of prawns with a size distribution achievable under research conditions to about $2,400,000 for a 12 tonne/ha/yr production with a target size distribution.

TABLE 3

Estimates of Gross Annual Income ($,000) for a 10 Hectare Operation for Various Ranges of Production and Market Price

Production - 6 tonne/ha/yr

	$/kg	Gross $
Wholesale	10	600
	15	900
Current wholesale price -- (8-14 count prawns)	18	1080
	20	1200
	25	1500
	30	1800
Highest retail price	35	2100

Production - 8 tonne/ha/yr

Wholesale	10	800
	15	1200
Current wholesale price -- (8-14 count prawns)	18	1440
	20	1600
	25	2000
	30	2400
Highest retail price	35	2800

Production - 10 tonne/ha/yr

Wholesale	10	1000
	15	1500
Current wholesale price -- (8-14 count prawns)	18	1800
	20	2000
	25	2500
	30	3000
Highest retail price	35	3500

Production - 12 tonne/ha/yr

Wholesale	10	1200
	15	1800
Current wholesale price -- (8-14 count prawns)	18	2160
	20	2400
	25	3000
	30	3600
Highest retail price	35	4200

TABLE 4

Proportion of Prawn Sizes at Harvest

No. of Whole Prawns / lb	Achieved Distribution of Prawns in Percent (Research Scale)	Target Distribution of Prawns in Percent (Commercial Scale)
> 30	4	0
24 - 30	30	10
16 - 23	34	40
12 - 15	17	20
9 - 11	13	18
< 7	2	12

TABLE 5

Estimates of Gross Annual Income ($,000) for a 10 Hectare Operation
Based on Achieved Research Scale (A) and Target Commercial Scale (T)
Harvest Distributions and Two Levels of Market Prices

Production - 6 tonne/ha/yr

Count prawns/lb	Achieved (A) %	Targeted (T) %	Price Level (1) $/kg	Price Level (2) $/kg	Gross A x 1	Gross T x 1	Gross A x 2	Gross T x 2
> 30	4	0	0	0	0	0	0	0
24 - 30	30	10	10	14	180	252	60	84
16 - 23	34	40	14	17	286	347	336	408
12 - 15	17	20	18	19	184	194	216	228
9 - 11	13	18	22	23	172	179	237	248
< 7	2	12	25	30	30	36	180	216
				Total Gross	852	1008	1029	1184

TABLE 5 (cont'd)

Estimates of Gross Annual Income ($,000) for a 10 Hectare Operation
Based on Achieved Research Scale (A) and Target Commercial Scale (T)
Harvest Distributions and Two Levels of Market Prices

Production - 8 tonne/ha/yr

Count prawns/lb	Achieved (A) %	Targeted (T) %	Price Level (1) $/kg	Price Level (2) $/kg	Gross A x 1	Gross T x 1	Gross A x 2	Gross T x 2
> 30	4	0	0	0	0	0	0	0
24 - 30	30	10	10	14	240	336	80	112
16 - 23	34	40	14	17	381	462	448	544
12 - 15	17	20	18	19	245	258	288	304
9 - 11	13	18	22	23	229	239	317	331
< 7	2	12	25	30	40	48	240	288
				Total Gross	1135	1343	1373	1579

TABLE 5 (cont'd)

Estimates of Gross Annual Income ($,000) for a 10 Hectare Operation
Based on Achieved Research Scale (A) and Target Commercial Scale (T)
Harvest Distributions and Two Levels of Market Prices

Production - 10 tonne/ha/yr

Count prawns/lb	Achieved (A) %	Targeted (T) %	Price Level (1) $/kg	Price Level (2) $/kg	Gross A x 1	Gross T x 1	Gross A x 2	Gross T x 2
> 30	4	0	0	0	0	0	0	0
24 - 30	30	10	10	14	300	420	100	140
16 - 23	34	40	14	17	476	578	560	680
12 - 15	17	20	18	19	306	323	360	380
9 - 11	13	18	22	23	286	299	396	414
< 7	2	12	25	30	50	60	300	360
				Total Gross	1418	1680	1716	1974

TABLE 5 (cont'd)

Estimates of Gross Annual Income ($,000) for a 10 Hectare Operation
Based on Achieved Research Scale (A) and Target Commercial Scale (T)
Harvest Distributions and Two Levels of Market Prices

Production - 12 tonne/ha/yr

Count prawns/lb	Achieved (A) %	Targeted (T) %	Price Level (1) $/kg	Price Level (2) $/kg	Gross A x 1	Gross T x 1	Gross A x 2	Gross T x 2
> 30	4	0	0	0	0	0	0	0
24 - 30	30	10	10	14	360	504	120	168
16 - 23	34	40	14	17	571	694	672	816
12 - 15	17	20	18	19	367	388	432	456
9 - 11	13	18	22	23	343	359	475	497
< 7	2	12	25	30	60	72	360	432
				Total Gross	1701	2017	2059	2369

Operating expenses for a 10 hectare operation are listed in Table 6. Total costs are anticipated to be about $1,120,000 per year without cost cutting measures. Heating costs were calculated using 1989 steam rates at the Bruce Energy Park. Labour costs were determined from equivalent positions in trout farms in Ontario. Expenses for food, juveniles and other expenses were estimated using values obtained from Shang (1981).

As discussed earlier two areas of operating expenses are amenable to significant cost reduction, heating and feeding. The use of a 50 % heat retention fabric in the green houses would reduce heating costs to about $230,000 per annum. Assuming food costs can be cut in half by bulk purchasing of commercially prepared food, using alternate food sources as dietary supplements and feeding back prawns with low growth potential, food costs would be about $205,000 per year. Thus, annual operating expenses may be reduced to as low as $690,000 for a 10 hectare operation.

Table 7 summarizes a number of possible incomes (losses) available for carrying capital costs and for profit after operating expenses. Although there is a wide range of values to be considered, focusing on mid range values would likely be most revealing. Assuming the lower estimates for operating costs, income after estimated operating expenses would be between $700,000 to $1,000,000 for a 10 hectare operation. Profit would then depend on the cost of servicing the capital investment including land costs.

This analysis offers a general outline and approach to defining expenses and potential profits for those unfamiliar with the potential of thermal freshwater prawn culture. Although similar enterprises are not available for comparison, operating costs can be reasonably well defined. The interdependence of design, materials and construction costs makes definition of capital costs difficult. Ultimately the final design (and cost) will depend not only on more detailed analyses but also on the experiences gained during a pilot production phase. Much will hinge on the ingenuity of the engineers who design and refine the pilot facility and the researchers and managers involved in its daily operation.

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TABLE 6

Comparison of Estimates of Annual Operating Expenses ($,000)
for a 10 Hectare Prawn Farm With and Without
Cost Cutting Measures

Expense	Details of expense	Costs	Costs Reduced
Heat	7000 MBTU/acre/yr = 17297 MBTU/ha/yr @ $2.65/MBTU [1]	458	229
Labour	$35,000 Manager $58,000 Labour @ $10/hr	89	89
Food	142 kg/ha/day @ $36/hwt [2]	410	205
Juveniles	$10/$m^2$ stocked @ 200/m^2 in rearing raceways/growout/greenhouse [2]	65	65
Other	Electricity, water, maintenance, etc [2]	99	99
	Total Operating Expenses	1121	687

[1] Stephenson, 1990, personal communication

[2] estimated from Shaug (1981)

TABLE 7

Estimates of Income Before Capital Carrying Costs for a 10 Hectare Prawn farm for Various Ranges of Operating Costs, Production and Market Prices ($,000)

Operating Expenses - $1121

Production (tonne/ ha/yr)	Achieved Gross 1	Achieved Gross 2	Targeted Gross 1	Targeted Gross 2	Achieved Income 1	Achieved Income 2	Targeted Income 1	Targeted Income 2
6	852	1008	1029	1184	-269	-113	-92	63
8	1135	1343	1373	1579	14	222	252	458
10	1418	1680	1716	1974	297	559	595	853
12	1701	2017	2059	2369	580	836	938	1248

TABLE 7 (cont'd)

Estimates of Income Before Capital Carrying Costs
for a 10 Hectare Prawn farm for Various Ranges of
Operating Costs, Production and Market Prices
($,000)
Operating Expenses - $687

Production (tonne/ ha/yr)	Achieved Gross 1	Achieved Gross 2	Targeted Gross 1	Targeted Gross 2	Achieved Income 1	Achieved Income 2	Targeted Income 1	Targeted Income 2
6	852	1008	1029	1184	165	321	342	497
8	1135	1343	1373	1579	448	656	686	892
10	1418	1680	1716	1974	731	993	1029	1287
12	1701	2017	2059	2369	1014	1330	1372	1682

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